

# BIOLOGY OF THE HUMAN BODY

## BOHB-16

### The Human Menstrual Cycle

**Menstrual cycle.** During menstruation, the endometrium slowly begins to die (*necrosis*) and sloughs off bits of its compact and spongy layers, leaving small bleeding areas. Following menstruation the cells of these layers begin to grow, causing the endometrium to reach a thickness of 2 or 3 millimeters by the time of ovulation. During this period the endometrium grows thicker and more vascular, until after ovulation it reaches a maximum of about 4 to 6 millimeters' thickness. The swelling of the endometrium is due to fluid retention as well as proliferation of *endometrial cells*. The day before menstruation starts again, the blood supply to the endometrium is diminished, leading to necrosis, sloughing, and once again menstrual bleeding.

The menstrual cycle is customarily divided into phases in which major processes occur. These phases are *menses*; the *postmenstrual*, or

*post = after*

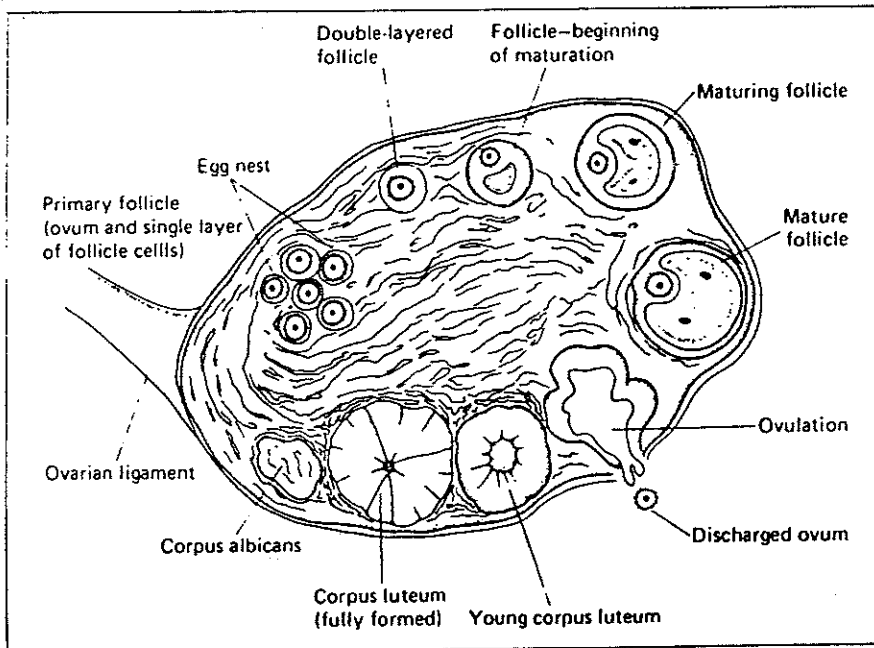


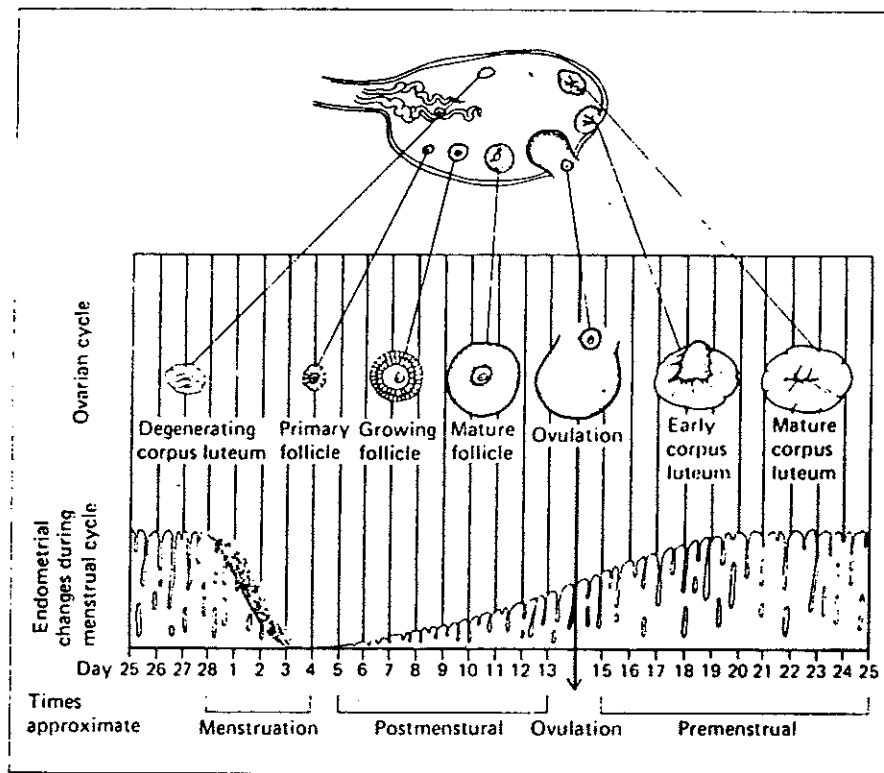
Figure 29-6 Diagram of an ovary showing successive stages of ovarian follicle and ovum development.

*preovulatory, phase; ovulation; and the postovulatory, or premenstrual, phase.* (Refer to Fig. 29-7.)

The menses or menstrual period occurs on cycle days 1 to 5. There is some individual variation, however, that falls within the normal range. The postmenstrual phase occurs between the end of the menses and ovulation. Therefore it is also called preovulatory. In a 28-day cycle, it usually includes cycle days 6 to 13 or 14. But the length of this phase varies more than do the others. It lasts longer in long cycles and ends sooner in short ones. This phase is also called the *estrogenic, or follicular, phase* because of the high blood estrogen level resulting from secretion by the developing follicle.

**Ovulation**, that is, the rupture of the mature follicle with expulsion of its ovum into the pelvic cavity, occurs frequently on cycle day 14 or 15 in a 28-day cycle. However, it occurs on different days in different cycles, depending on the length of the preovulatory phase. For example, in a 32-day cycle the preovulatory phase would probably last until cycle day 17 or 18 and ovulation would then occur on cycle day 18 or 19.

Figure 29-7 Schematic representation of one ovarian cycle and the corresponding changes in thickness of the endometrium. It is thickest just before the onset of menstruation and thinnest just as menstruation ceases.



**Gonadotropic cycle.** The anterior pituitary gland secretes two hormones called *gonadotropins* that influence the female reproductive cycles. Their names are *follicle-stimulating hormone (FSH)* and *luteinizing hormone (LH)*. The amount of each gonadotropin secreted varies with a rhythmic regularity that can be related to the rhythmic ovarian and uterine changes.

## Function of Anterior Pituitary Hormones

*Gonadotropic hormones*, also known as *gonadotropins*, control the growth, development and functions of the gonads (the testes and ovaries). One is the *follicle-stimulating hormone (FSH)*. In the female, this hormone stimulates the development of follicle cells, which surround each developing egg in the ovary. In the male, it stimulates the testes to produce sperm cells. The presence of FSH is under the influence of the hypothalamus, which produces *follicle-stimulating hormone releasing factor (FSHRF)*. FSHRF is released in response to sex hormones produced by the gonads and involves the negative-feedback system. Another gonadotropin is the *luteinizing hormone (LH)*. In the female, LH is essential for ovulation (the discharge of the egg from the ovary) and the conversion of the follicle, after ovulation, into a separate glandular structure, the *corpus luteum*. LH in the male, sometimes referred to as the *interstitial cell-stimulating hormone (ICSH)*, stimulates the interstitial cells within the testes to produce testosterone.

During pregnancy, female sex hormones (estrogen and progesterone) stimulate the development of the breasts in preparation for feeding the child. *Prolactin*, or lactogenic hormone, activates the breasts in producing milk. It may also play a role in maintaining the corpus luteum of the ovary during pregnancy.

## Secretion of the Gonads

All the secondary sex characteristics fail to develop if the gonadotropic hormones, the follicle-stimulating hormone (FSH), and the luteinizing hormone (LH) are missing or greatly deficient in quantity. These hormones are responsible for the development of the gonads, which in turn produce male and female hormones. (See Fig. 28-9.)

**Androgens.** The male sex hormones are considerably less complex than those of the female since they are not concerned with the menstrual cycle, a developing child, or childbirth. The hormones produced by the interstitial cells of the testes are known by the general name of **androgenic hormones**. Of these steroids, the principal one is testosterone, which is by far the most potent and most abundant. It is a 19-carbon steroid synthesized from cholesterol.

*andro = male*

Testosterone is responsible for the development of adult primary sexual characteristics. During development the penis, scrotum, and testes increase in size. The internal prostate and bulbourethral glands enlarge and become active. As mentioned before, testosterone is responsible for the development of the male secondary sex characteristics.

**Estrogens.** The female gonads, paired ovaries, produce ova and the female sex hormones estrogen and progesterone. Each ovary, about the size and shape of a large almond, consists of an outer covering layer of columnar epithelial cells called the **germinal epithellum**. Beneath this covering is connective tissue called **stroma**, which is divided into a cortex and inner medulla. It is within the cortex that one finds thousands of immature ova, each surrounded by a layer of flattened epithelial cells forming a **follicle**. With the onset of puberty, under the influence of FSH, approximately 400 follicles will mature in the ovaries during the reproductive years of the female. It is from these follicular cells that the first group of female sex hormones is produced, the **estrogens**. One of these is **beta-estradiol**, the most potent and maybe the true female sex hormone. When an ovum is matured and released (ovulation) under the influence of LH, the follicular cells, now void of the ovum, form a new glandular structure, the **corpus luteum**, which produces the second ovarian hormone, **progesterone**. It is the balance that exists between the concentration level of two gonadotropic hormones of the adenohypophysis (FSH and LH) and the resulting formation of estrogen and progesterone that controls the various phases associated with the menstrual cycle (discussed in Chapter 29, Reproduction and Development).

### Critical Thinking and Application

1. Why are the events described in this investigation referred to as a cycle?

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2. The word "menstrual" comes from the Latin word *mensis*, meaning "month." How is the name appropriate for this cycle of the human female reproductive system?

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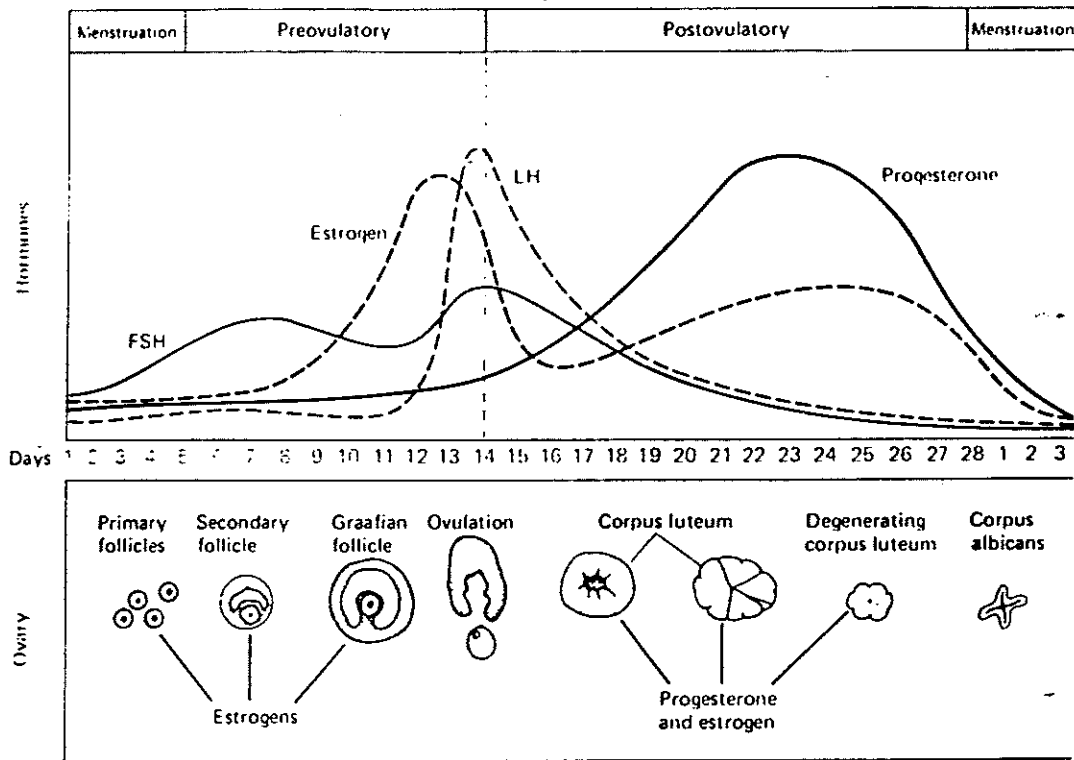


Figure 28-9 Diagram showing relationship between the ovarian hormones and those of the anterior pituitary.

3. During which days of the menstrual cycle is the level of FSH at its lowest in the bloodstream?

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4. About how long is the follicle phase of the menstrual cycle? \_\_\_\_\_

\_\_\_\_\_

5. On which day of the menstrual cycle is the production of LH the greatest?

\_\_\_\_\_

6. What event occurs immediately after this increased production of LH?

\_\_\_\_\_

7. What happens to the corpus luteum during days 15 through 24 of the menstrual cycle?

\_\_\_\_\_

8. a. During which days of the menstrual cycle is the production of LH the lowest?

\_\_\_\_\_

b. What is happening to the corpus luteum at this time? \_\_\_\_\_

\_\_\_\_\_

9. a. What happens to the amount of estrogen produced by the body during days 6 to 12 of the menstrual cycle? \_\_\_\_\_
- \_\_\_\_\_
- b. What is occurring to the uterus during this time? \_\_\_\_\_
- \_\_\_\_\_
10. a. What happens to the amount of progesterone produced by the body during days 13 to 23 of the menstrual cycle? \_\_\_\_\_
- \_\_\_\_\_
- b. What is occurring to the uterus during this time? \_\_\_\_\_
- \_\_\_\_\_
11. a. During which days of the menstrual cycle are the levels of both estrogen and progesterone at their lowest? \_\_\_\_\_
- \_\_\_\_\_
- b. What event is occurring at this time? \_\_\_\_\_
- \_\_\_\_\_

### The Menstrual Cycle: Interpreting Diagrams

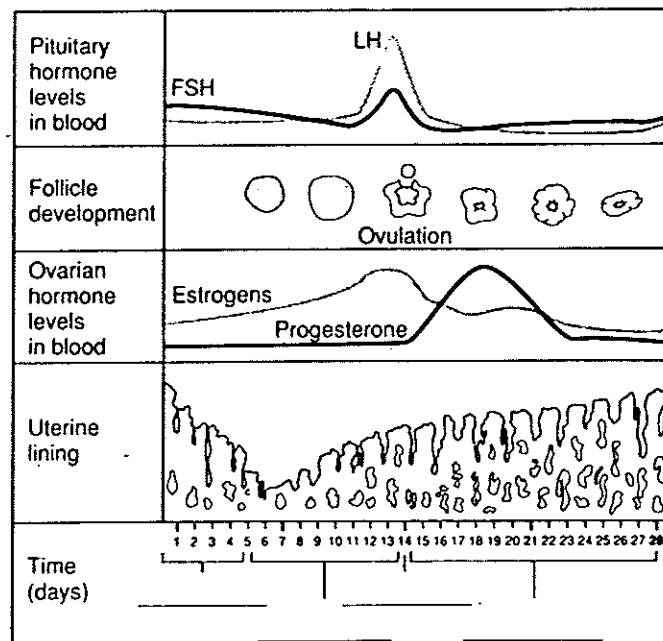
1. Use the terms listed below to correctly complete the diagram. Then use the correctly labeled diagram to answer the questions that follow.

ovulation

menstruation

luteal phase

follicle phase



2. What happens to the levels of FSH, LH, and estrogens in the blood during ovulation?

\_\_\_\_\_

3. What hormone level increases following ovulation? \_\_\_\_\_

4. During menstruation, what happens to the uterine lining? \_\_\_\_\_

\_\_\_\_\_

5. In terms of the follicle, when does ovulation occur? \_\_\_\_\_

### Analysis and Conclusions

1. How is the name follicle-stimulating hormone appropriate for its function?

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\_\_\_\_\_

2. How is the name luteinizing hormone appropriate for its function?

\_\_\_\_\_  
\_\_\_\_\_

3. Based on your observations, do you think estrogen and progesterone both cause similar changes in the uterus? Explain your answer. \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

4. What events occur during the follicle phase of the menstrual cycle?

\_\_\_\_\_  
\_\_\_\_\_

5. What events occur during the luteal phase of the menstrual cycle?

\_\_\_\_\_  
\_\_\_\_\_

6. If a female did not produce sufficient quantities of FSH and LH, how would her ability to have children be affected? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

### Uterine Changes During the Menstrual Cycle

1. As the follicle and luteal phases of the menstrual cycle occur, a series of changes occurs in the uterus. Through rapid cell division, the lining of the uterine walls becomes very thick. At one point in the menstrual cycle, the uterus lining ceases to thicken and begins to break apart. This loss of the uterine lining through the vagina is called menstruation. See Figure 5.

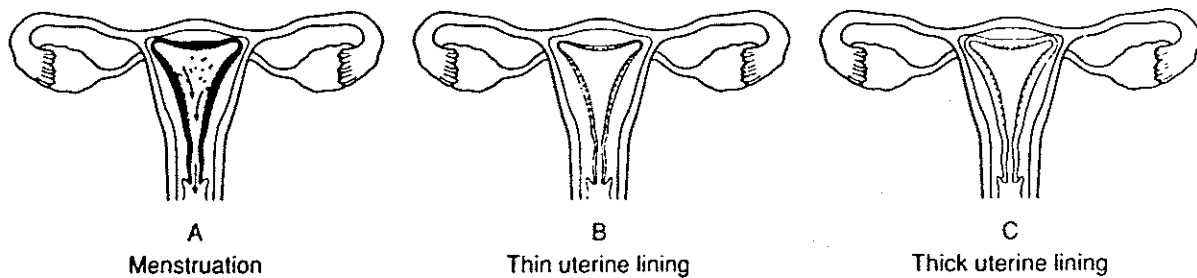


Figure 5

Two hormones that are responsible for the building up of the uterine lining are estrogen and progesterone.

1. Describe the level of estrogens in the blood at the beginning of the follicle phase.  
\_\_\_\_\_  
\_\_\_\_\_
2. How does the hypothalamus react to the level of estrogens at the beginning of the follicle phase?  
\_\_\_\_\_  
\_\_\_\_\_
3. What happens to the lining of the uterus when estrogen levels rise?  
\_\_\_\_\_  
\_\_\_\_\_
4. Which phase is the shortest phase in the cycle? What hormonal activity begins this phase?  
\_\_\_\_\_  
\_\_\_\_\_
5. What hormone is released by the corpus luteum immediately after ovulation?  
\_\_\_\_\_
6. During what phase are the chances of an egg being fertilized greatest?  
\_\_\_\_\_
7. If the egg is not fertilized, a particular hormone falls below a certain level and signals the start of menstruation. What is this hormone?  
\_\_\_\_\_

# Menstrual Cycle

Fig. 1

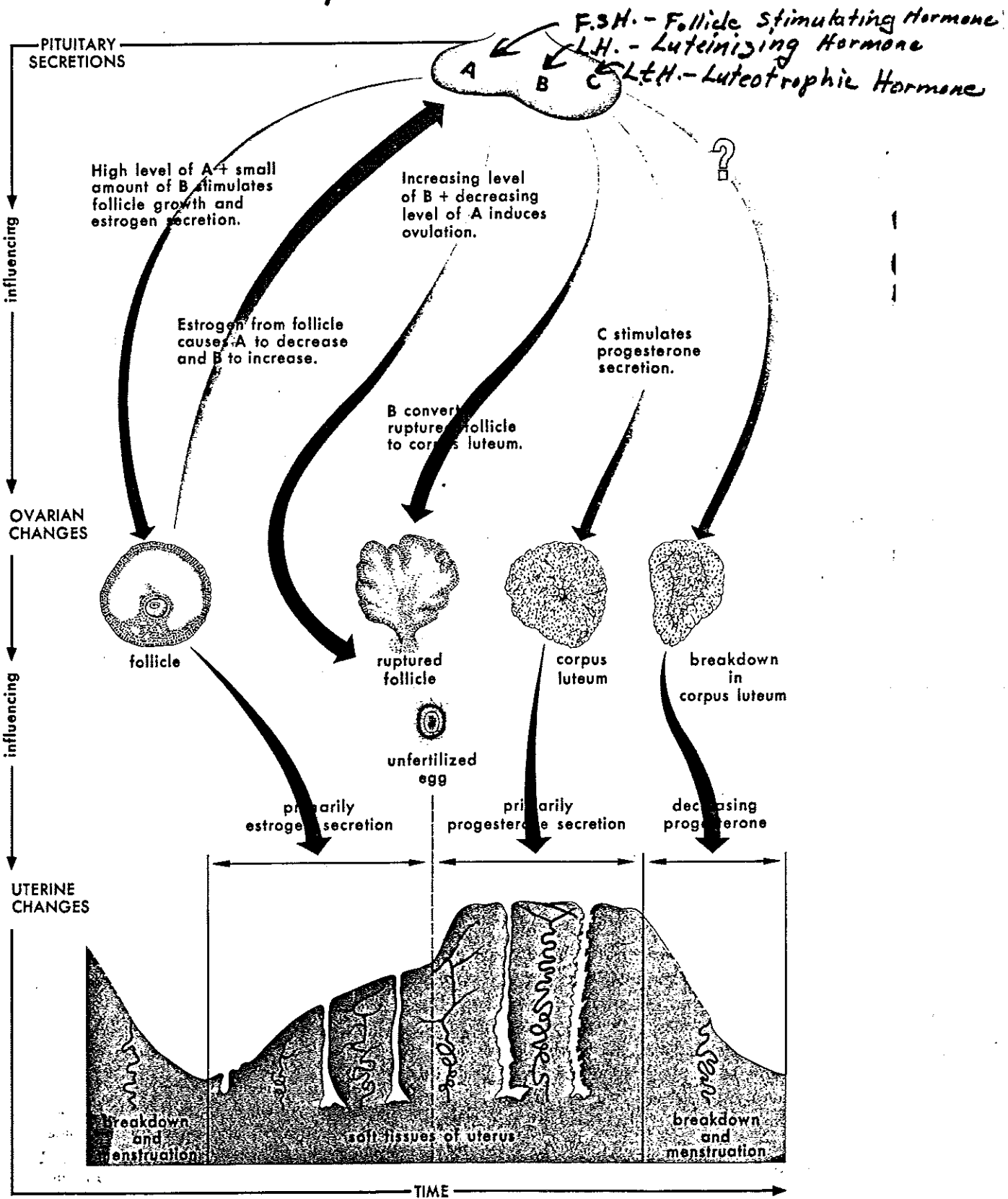


Fig. 2

The general relationship between the activities of the pituitary gland, ovaries, and uterus.

